

CURABLE SILICONE SEMI-INTERPENETRATING POLYMER NETWORKS AND METHODS OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my co-pending U.S. application Ser. No. 370,000, filed Apr. 20, 1982, now U.S. Pat. No. 4,500,688 for "Curable Silicone Containing Compositions."

BACKGROUND OF THE INVENTION

This invention concerns compositions which can be described as melt processable pseudointerpenetrating networks of silicones in thermoplastic matrices. This invention also relates to methods for the formation of these compositions.

Previous investigations have demonstrated that silicones may be incorporated into thermoplastic resins at low levels in order to enhance wear, friction and release properties. These silicones, however, are low molecular weight resins which are readily extractable from the matrix resins. Incorporation of silicone at levels above 2% can cause catastrophic reductions in mechanical properties and melt rheology.

The present invention reveals that judiciously selected silicone systems which are vulcanized within a thermoplastic matrix to form pseudointerpenetrating polymer networks (also referred to as semi-interpenetrating polymer networks or semi-IPNs) will not adversely affect polymer properties.

Interpenetrating polymer networks are described by L. H. Sperling in *Interpenetrating Polymer Networks and Related Materials*, Plenum Press, New York and London (1981). A full or true interpenetrating polymer network (IPN) is a material containing two polymers, each in network form, with the two polymers having been polymerized or vulcanized independently in the presence of each other to form two networks which are intertangled (interpenetrated) with each other. The IPNs may be formed in different manners, with the synthesis (polymerization) and/or cross-linking (vulcanization) of the two polymers being sequential or simultaneous. Another mode of IPN synthesis involves simultaneous coagulation and cross-linking of two latex polymers to form an interpenetrating elastomeric network.

One type of IPN system is illustrated in U.S. Pat. No. 4,302,553 of Frisch et al. IPNs of this sort involve a blend of two different prepolymers cross-linked in independent processes and permanently entangled with one another. These IPNs are thermoset in character.

Semi- or pseudo-IPNs have only one cross-linked phase or network which is within a continuous unlinked polymer matrix phase. It is possible with certain solvent soluble resins to extract this non-cross-linked phase, whereas that is not possible for the true IPN. As a result, the true IPN systems must be cast since once the components are admixed and the polymer formation takes place, the interpenetrating networks cannot be separated. The single cross-linked network of the pseudo- or semi-IPNs allows these materials to retain thermoplastic character, although pseudo-IPNs with thermosetting properties are also possible.

SUMMARY OF THE INVENTION

There have now been discovered new compositions comprising a silicone component vulcanized within a polymeric thermoplastic matrix to form a pseudointerpenetrating polymer.

This invention is also directed to methods of producing pseudointerpenetrating silicone polymer networks by curing or vulcanizing a silicone within a polymeric thermoplastic matrix at elevated temperatures, preferably during normal thermoplastic melt processing.

Advantageous characteristics of the compositions of this invention are surface and dielectric properties which approach those of silicones and mechanical properties which approach those of the thermoplastic matrices. To achieve these pseudo- or semi-IPNs, only components of the silicone network react with themselves (e.g. silicone hydrides with vinylsilicones). The matrix thermoplastic is essentially "inert" and unaffected by the cross-linking process.

DETAILED DESCRIPTION OF THE INVENTION

The compositions of this invention are formed by the catalyzed curing or vulcanization of a silicone in a compatible polymeric thermoplastic matrix at elevated temperature. A silicone is any of a large group of siloxane polymers based on a structure comprising alternate silicon and oxygen atoms with various organic radicals attached to the silicon.

The amount of silicone in the resultant compositions of the present invention can range from between about 1 weight percent and about 60 weight percent.

Vulcanization (curing) can be defined as any treatment that decreases the flow of an elastomer, increases its tensile strength and modulus, but preserves its extensibility. These changes are generally brought about by the cross-linking reactions between polymer molecules, but for purposes of this invention, vulcanization is used in a broader sense to include chain extension as well as cross-linking reactions.

The polymeric thermoplastic matrices of this invention include conventional thermoplastic resins including, but not limited to polyamides, thermoplastic polyurethanes, bisphenol A polycarbonates, styrenics, polyolefins, polyacetals, styrene-butadiene copolymers, polyolefin elastomers, polyamide-polyether elastomer base resins, etc.

In one embodiment of this invention, a two-part vulcanizing silicone which, depending on molecular structure, will undergo predominantly chain extending or cross-linking reactions, is vulcanized in a suitable thermoplastic matrix. One polymeric silicone component of the two part silicone contains silicone hydride (Si-H) groups. The other polymeric component contains unsaturated groups, preferably vinyl. Non-limiting examples of other unsaturated groups that can be employed include allyl $-\text{CH}_2\text{CH}=\text{CH}_2$ and hexenyl $-(\text{CH}_2)_4\text{CH}=\text{CH}_2$. Alternatively, both the hydride and unsaturated group can be part of one polymeric silicone. In the presence of a catalyst, generally a platinum complex, silicone hydride adds to the unsaturated group, e.g., a vinyl group, to create an ethylene linkage as follows: